ELECTROCHEMISTRY OF FUNCTIONALIZED POLYANILINE USING DIFFERENT DOPANTS

A Synopsis submitted for commencement of

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1. Introduction

Polymers are ubiquitous and can be synthetic or natural, consisting of long atom chains connected by a strong covalent connection as suggested by H. Staudinger [1]. A renaissance transformation was facilitated through a phenomenon known as reversible doping or de-doping [2] that alters the insulated undoped polymers into conducting polymers [3] that bring about the electrical conductivity in the material. The electrical conductivity exhibited by doping in π-conjugated polymers has inspired numerous researchers to synthesize intrinsically conducting polymers [4–9] as shown in (**Figure 1**)

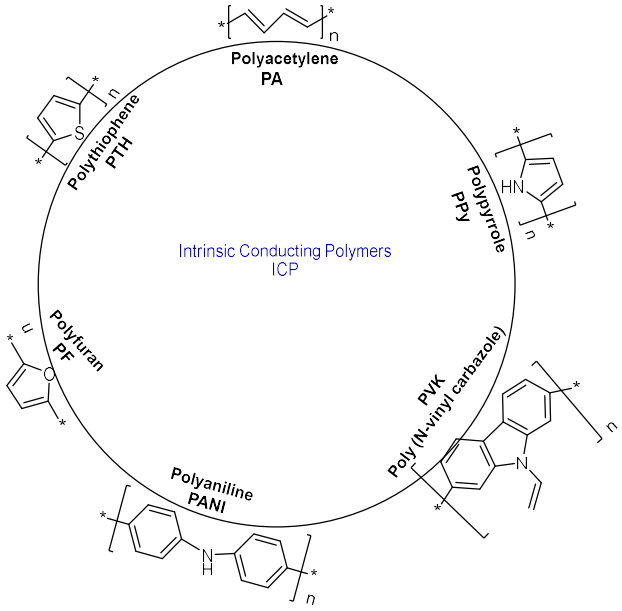


Fig 1. Arrays of different intrinsically conducting polymers

Among these polyanilines were recognized as an enthralling and erratic subordinate of the session of π-conjugated conducting polymers [10–12] that acknowledged great consideration due to its eco-friendly stability [13], simple synthesis, fascinating optical, electrochemical, and electrical characteristics, and it has been proposed as a latent material associate for a variety of uses, including light-emitting devices, sensors, electromagnetic shielding, photovoltaic, and biological applications, etc [14–16]. Different varieties of fundamental Polyaniline (PANI) were predicted by MacDiarmid in 1997 [17] such as leuco-emeraldine base (LEB), emeraldine base (EB), and pernigraniline base (PAB). The majority of the polyaniline was present as emeraldine base (EB). Acid protonation of the imine nitrogen of the emeraldine base converts it from non-conducting to conducting. By utilizing

protonic acids as a dopant [18] in oxidative doping processes, EB can be converted into a conducting state, whereas LEB and PAB cannot (**figure 2**).

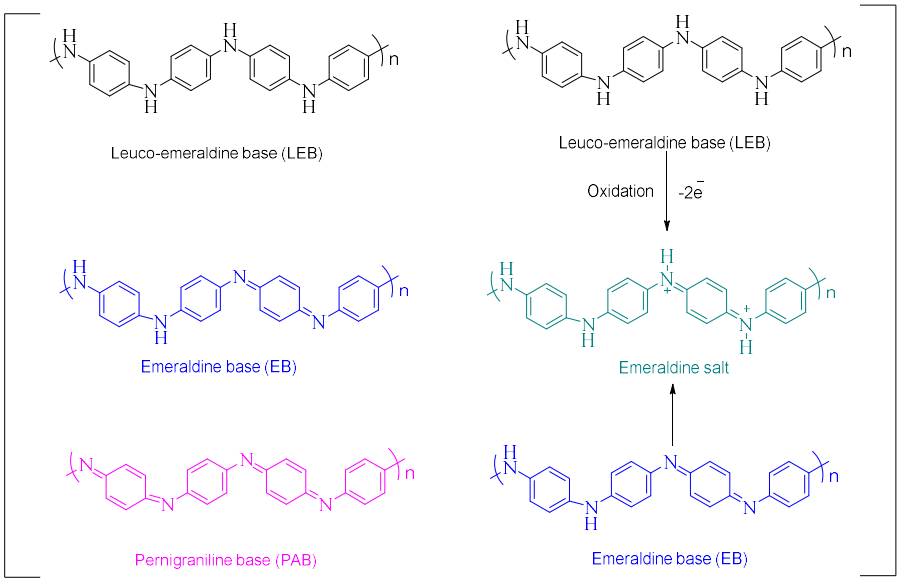


Fig.2 Different varieties of fundamental Polyaniline

However, preparation techniques for polyaniline in the works of literature mingle with some limitation that reduces its processability [19–23]. Thus, the various functional pitches of electrochemistry were used to increase the processability of polyaniline by adjusting several variables, including potential, charge, time, temperature, pH, ionic strength, and supporting electrolyte. This resulted in the creation of new, practical synthetic stratagems with endless potential. [13,24–29]. The merit of synthetic organic electrochemistry [30,31] in the tailoring of polyaniline with enhanced features such as prolonged conjugation, solubility, electrochemical activity, thermal stability, and controlled shape. The chronological chain of

electrochemistry by Faraday [32] and Kolbe [33] finds the flow of electric current through an electron-driven chemical reaction. This electrochemical reaction has an extensive assortment of applications that may be employed as power sources, actuators, corrosions, sensors, etc [34–36]. Polymer structure and morphology are greatly influenced by the electro-synthetic conditions, which include the electrode materials, the solvent and electrolyte salts, the system's concentration of oxygen and water, and the current density used for electro-polymerization [37]. To improve the number of possible scanning cycles for the electrochemical synthesis of polyaniline, we had to comprehend the cyclic voltammetry approach (CV) as demonstrated by A. Montes-Rojas and co-workers [38]. One of the main advantages of CV is its ability to control the conductive polymer's morphology as well as the quantity deposited on a facade. This is achieved by counting the optimal number of potential scanning cycles that yield the current magnitude for each response, at a guaranteed potential scan rate, and within the appropriate potential boundaries. It is an adaptable method that has demonstrated its importance in the electrochemical synthesis of conductive polymers [39]. Definite evidence that the degree of protonation plays a vital role in increasing the expanse and quality of functionalized polyaniline was demonstrated by Sahin et al. [40–42]. In a solution containing neutral, basic, and acidic blank, they explain the pH response on the electro-activity

behaviour of functionalized poly (2-iodo/bromo/chloro)-co-aniline) by varying the electroactivity behaviour.

2. Objective

1. Electrochemical synthesis of functionalized polyaniline through doping with organic and inorganic acid with alteration of functional segments:
2. Concise electrochemical behavior study by using cyclic voltammetry
3. Optimization, isolation, purification, and characterization of the synthesized compounds through UV-Visible, IR, NMR, and SEM.

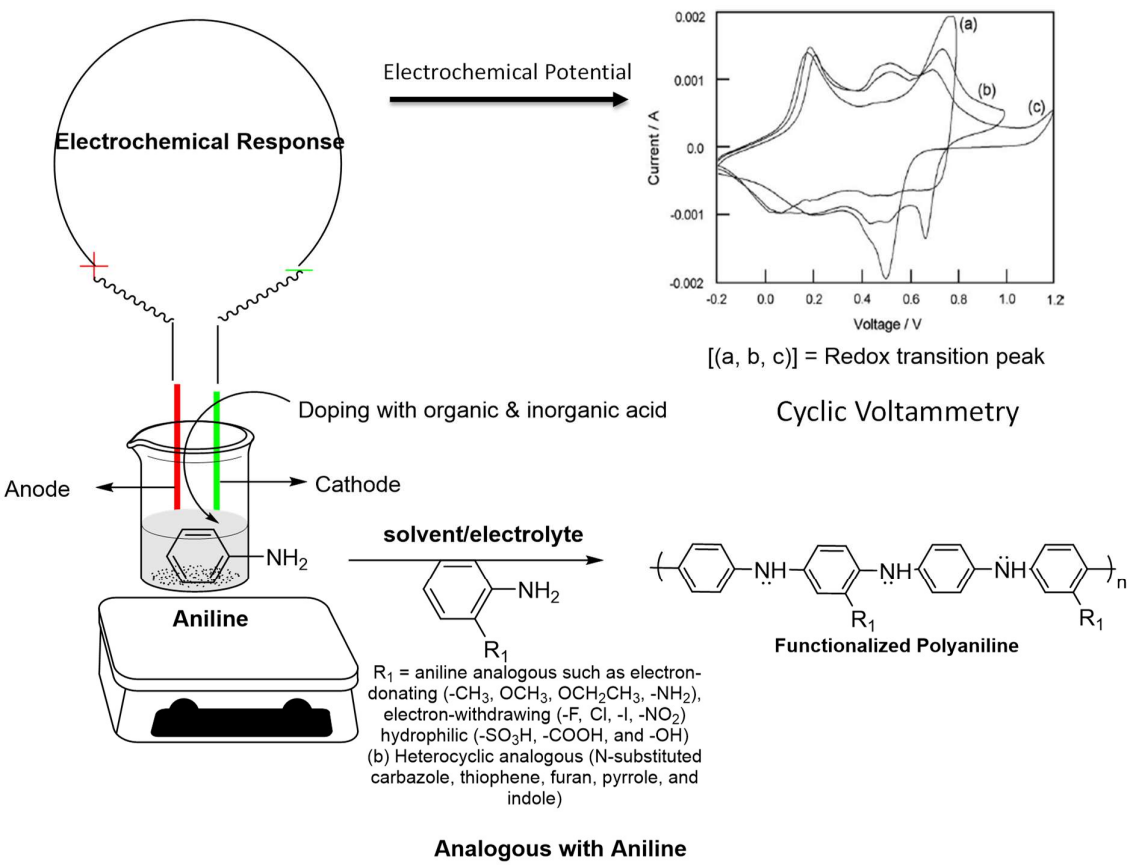
3. Methodology

1. To achieve our objective the electrolysis will be performed at constant potential called the potentiostat technique, which contains a 100 mL three-electrode cell assembly with platinum plate (flattened sheet with a dimension of 5.0 cm x 5.0 cm), a counter electrode, and saturated calomel electrode as a reference electrode.
2. Different reaction media with supporting electrolyte will be employed along with inorganic and organic acid as dopants.
3. Aniline analogous such as electron-donating (-CH_3, OCH_3, OCH_2CH_3, -NH_2), electron-withdrawing (-F, Cl, -I, -NO_2) and

hydrophilic (-SO_3H, -COOH, and -OH) (b) Heterocyclic analogous (N-substituted carbazole, thiophene, furan, pyrrole, and indole) are of analytical grade are needed

4. Double distilled water has to be used in preparing the supporting electrolyte solution

5. Cyclic voltammetry experiments have to be performed to monitor the redox behaviours.



6. Spectroscopic grade solvents must be used for spectral measurements such as UV-visible, IR, ^{1}H-NMR and ^{13}C NMR spectra. Testing was carried out taking only the soluble portion of polymer in DMF. Chemical shifts are reported in ppm downfield from TMS as an internal reference

7. The morphology and particle size must be determined using a scanning electron microscope (SEM)

4. Future prospective

1. Supportive to untrained chemists that can use this electrochemical power for innumerable other organic electrolysis.

2. Reactions are given with a solitary reagent, an electron, making the procedure environmentally benign

3. Exploration of galvanic potential towards the synthesis of co-polymer reaction encourages toward environmentally benign synthetic protocol of organic electrochemistry.

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